ABSTRACT: Methods for automatically controlling the processing of fibrous materials from bulk unrefined form to accepted refined furnish stuff condition, and meter proportioning the furnish stuff from refining density with a liquid vehicle to obtain a machine forming-density at flow volume rates, in accordance with the machine forming demand rate for the papermaking or allied purpose.
METHOD OF AUTOMATING THE OPERATION OF PAPER STOCK PREPARATION PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The automatic control of the processing rates of fibrous materials as furnish ingredients according to a selected metered ratio thereof and the readjustment of the furnish composition to a machine forming density at a flow rate responsive to the machine forming demand.

2. Description of the Prior Art


SUMMARY OF THE INVENTION

The invention teaches means for regulating the processing rate of fibrous materials in a continuous flow in accordance with a machine demand (C) being limited only to an accepted stock degree of refining, and also means for obtaining a predetermined readjusted selective density value suitable for the forming machine purpose.

It provides the means for the separate and simultaneous processing of fibrous materials having unlike processing characteristics, each to a predetermined degree of refining and at a rate in accordance with the demand for such as ingredients of a composite type of furnish in a selected ratio of those ingredients at rates also as established by the machine forming demand.

The invention teaches means for: (1) automatically feeding proportioned unit quantities of liquid and fibrous materials into a single processing line composed of processing components arranged for the processing of certain types of fibers of a certain beating degree type such as chemical pulps, either singularly or in combinations of such, at processing rates in accordance with the forming machine demand, as meter proportioned from the refining density to the machine forming density, all as initiated by the machine forming demand; (2) as conditions require, automatically feeding proportioned unit quantities of liquid and materials into a single processing line composed of processing components arranged for the processing of long fibers of a high beating degree type such as derived from the hair seed family either singularly or in combinations of such, as meter proportioned from the refining density to the forming machine density according to the forming machine demand; (3) A. automatically and simultaneously feeding into each line, same being jointly operated and controlled as part of an integrated multiprocesing system, whereby unit quantities of liquid and unspecified short fiber low beating degree type materials are fed to one line and unit quantities of liquid and unspecified long fiber high beating degree type materials are fed to the other line, wherein the liquid-to-fiber ratio in each line is maintained at the same value for obtaining like stock densities in both lines; B. simultaneously and automatically controlling the degree of fiber refining within each line in accordance with the nature of the material and to a separately selected accepted stock condition set therefor and also maintaining slurry volume flows at rates according to demands for such, by automatically controlling the rotating speeds of the refining components within each line as required in supplying a composite furnish mixture; C. automatically metering the so-refined stocks from the separate lines into a single composite furnish mixture in a continuous flow, in accordance with predetermined furnish ingredient composition ratios, maintained by differentially manipulating the operative speed ratio relationship between companionily matched separate process-line metering pumps, as to appropriately proportion the separate line slurry volume flows to the composite furnish ratios; and D. automatically metering the so-formed composite furnish mixture from the refining density at which it was formed, with selective unit quantities of liquid vehicle to machine forming density by differentially manipulating the operative speed ratio relationship between companionily matched furnish stuff and liquid vessel metering pumps and thereafter automatically regulating the speeds of both pumps jointly in accordance with the machine formed demand.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic diagram of one form of a automated two-line system, composed of separate material proportioning and processing lines, identified for convenience as lines A and B, and showing the control of the principle components essential to the mechanical operation and treatment control of the fibrous materials and the slurries formed therefrom; and FIG. 2 is a simplified schematic diagram showing the means for controlling the speeds of the metering pumps.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference are herein made to certain types of apparatus as components, but the invention comprehends the inclusion of other types of components as may be generally suited to the processing technique and suitably responsive to impulse regulation and manipulation control.

Instrumentation is provided in each line for the automatic and simultaneous continuous flow processing of materials having different processing requirements. For example, chemical pulps and similar woody-type fibers may be used in what will be referred to as the "A" line of the figure, and nonwoody-type fibers such as cotton and other similar natural fibers and the various derivatives therefrom including the various type and grades of rags may be used in what will be referred to as the "B" line on the right side of the Figure.

Conveyors 2A and 2B are used which are suitable for conveying and depositing into the respective material conditioning and slurring components 4A and 4B, respectively predetermined unit weight quantities of material 6A and 6B on the energizing of respective conveyor drives 8A and 8B, by the passage of unit quantity volumes of liquid through conduits 10A and 10B respectively. Meters 12A and 12B respectively are located in said conduits.

Meter impulse contact devices 14A and 14B and magnetic contactor coils 16A and 16B in circuits 18A and 18B respectively effect closure of magnetic contactor switches 20A and 20B respectively of conveyor drive circuits 22A and 22B respectively according to predetermined liquid-to-fiber ratio value calibration adjustment settings of the meter impulse contact devices so as to maintain equal and like slurry density values within both lines "A" and "B".

Each conveyor drive circuit 22A and 22B is provided with an AC to DC rectifier 24A and 24B respectively and a rheostat 26A and 26B respectively to synchronize the material delivery rates by respective conveyors 2A and 2B to the slurry inflow rates through respective meters 12A and 12B.

Meter impulse contact devices 14A and 14B are adjusted to make contact upon the passage of unit quantities of liquid in appropriate volume and, automatically controlling the degree of fiber weights in order to attain predetermined equal slurry density values (the material moisture content values being compensated for). Thus, lines "A" and "B" are both readied for operation simultaneously upon establishing a liquid pressure within a common conduit 28 supplied by a white water sump.
30 fed from a white water conduit 32 connecting to a white water source (not shown) and supply pump 34 and fresh water makeup via conduit 36 and float valve 38, with section valves 40A and 40B in conduit 28 both being closed.

Normally, to manually put the slurring phases of either lines “A” and “B” in readiness, headbox valves 42A and 42B connecting with lines 44A and 44B respectively are held in closed position and conveyors 2A and 2B are loaded with appropriately arranged and sized bundles of materials 6A and 6B respectively.

Conditioning and slurring component 4A and a blender 46A is rendered operational while in a dry condition. Then a normally closed switch 48A is put in temporary open position to prevent automatic propulsion of conveyor 2A until after a reservoir 50A has been filled to its normal operating level. On checking the reading of meter 12A, liquid supply valve 40A is partly opened to allow liquid to flow through meter 12A, along conduit 10A, into conditioning and slurring component 4A, and into reservoir 50A.

Normally open switch 49A is momentarily closed to control manually at a delayed rate the inflow of unit quantities of fibrous material bundles in accordance with the flow of unit quantities of liquid as indicated by the meter and without overloading the conditioning and slurring component 4A during the filling of reservoir 50A.

After the reservoir is filled to its normal operating level, switch 48A is restored to normal closed position, thereby putting the slurring phase under the automatic control condition, at which time section valve 40A is put in its normal open position.

To start the slurring phase of line “B” in readiness for automatic control involves an identical sequence and order.

Components 4A and 46A of line “A” may be of types exemplified in application Ser. No. 315,589 and suited for the more readily slurried pulps, while components 4B and 46B of line “B” may be of types exemplified in application Ser. No. 493,009 and suited for the tougher pulps.

Refiners 60A, 62A and 64A of line “A” may be of a type employing a combination of features exemplified in said applications Ser. No. 315,589 and 493,009 and/or combinations of modifications of same in order best to meet the fiber treating requirements anticipated for large volume continuous flow processing suited to a wide variety of the milder wood-derived pulps, which generally comprise the larger portion of composite mixtures requiring a minimum of gelatinization.

Refiners 62B and 64B of line “B” may, on the other hand, be of a type employing features more suited for batch processing the tougher nonwood-type fibers which may constitute only a small percentage of the final furnish mixture, but by virtue of the types of tackle employed, and method of manipulating same, may produce high gelatinization at rapid rates.

The refining phase of line “A” is of a form by which the slurry flows may be automatically controlled in the refining of the woody derivative types of fibers to an accepted stock condition with respect to a predetermined constant viscosity value, having low gelatinization and abnormally high freeness characteristics in a continuous flow within relatively wide ranges of fiber refinement with respect to strength and other characteristics.

Normally, the line “B” material-slurrying-conditioning phase would be the first to be started up, either from a dry state or otherwise, because of the relatively more extensive processing which the tougher types of fibers require.

For such fibers, components 4B and 46B are preferably of the types exemplified in application Ser. No. 493,009 because of the more effective and drastic treatment which these types offer. Because of this, refiners 60B, 62B and 64B are preferably of the type exemplified in said application, particularly when equipped with granular processing surfaces such as exemplified in application Ser. No. 655,190.

Line “B” also shows a flow line arrangement for processing the cooked rags as discharged from a bleach boiler 72B to a "half-stuff" condition under controls incorporated in a control panel 73B, preparatory to the subsequent material conditioning phase under the control of a control panel 74B.

Such "half-stuff" processing allows receipt of the cooked rags as discharged from the bleach boiler with a suitable open top trough-shaped vat 80B, fitted with a suitable slow revolving discharge screw 82B propelled by a gearhead motor drive 84B, being used for feeding the cooked rags to a slow travelling wire mesh liquor-draining-type conveyor 86B and allowing the spent cooked liquor to drain to waste ahead of a conveyor-type weighing device incorporated within the conveyor system by which the rags are delivered to a rag washer 88B in predetermined known batch quantities.

Rag washer 88B may be such as exemplified in application Ser. No. 315,589 showing relatively large fixed clearances suitable for maintaining adequate agitation within a reservoir or vat, with high volume flow rates for circulating the rags back to the reservoir during the washing period without undue work being expended on the fibers, preparatory to draining in a dewatering device 90B, from which the washed fibers are then in a condition to be bleached in a component 92B which may be similar to or a modified combination of components 88B and 90B.

After bleaching, the rags may then be processed in a component 94B of the type exemplified in my U.S. Pat. No. 3,227,606, by means of which the rags are subjected to an abrading action by the granular perimeter surface of a rotating member as the rag mass is extruded in a wad formation against that surface.

Following abrading, the fibers may be further reduced to an improved half-stuff condition by component 96B of the type exemplified in application Ser. No. 386,919, wherein the fibers are deformed and otherwise conditioned from a wad state between opposed granular surfaces preparatory for refining without need of the usual type of half-stuff drainage, in a continuous flow, portions of which may be diverted from a high density slurry storage chest 98B directly to conditioning and slurring component 4B under metering component 100B.

The balance of the high density half-stuff may be dewatered by a dewatering device 102B for subsequent pressing into suitable sized bundles or cakes by a press 104B for storage until reclaimed for conveyor 2B.

To set the refining phase of line “B” in operation, after the material-slurrying-conditioning phase has been put in operation, with slurry moving from blender 46B through a conduit 110B, a headbox 112B then to component 4B and back to reservoir 50B with valve 42B being in closed position, motorized dump valve 116B at refiner 60B discharge in closed position, variable speed, refiner drive 132B is started at moderate low speed, viscosity-sensing device 120B is energized, and motorized admission valve 122B is put in open position in readiness for receiving a batch of stock from reservoir 50B at a modulated flow rate until sensing device 124B signals impulses that cause the closure of admission valve 122B, by which procedure the batch processing is established in the refiner with a circulation of the stock being refined passing through a stock well 126B in which the rotor element of viscosity-sensitive device 120B is immersed, and is returned for further passes.

The speed of refiner 60B is adjusted according to the severity of the refining desired and the time available with respect to stock demand.

When the desired viscosity value has been achieved, dump valve 116B is caused to be opened so as to dump the batch into a reservoir 130B.

Impulse signals from a slurry-level-sensing device 130B at reservoir 120B may be utilized for the modulated increase or decrease in the driven speed of refiners 60B, 62B and 64B while these are "on-the-line" in accordance with the demands made on reservoir 120B.

The procedure of putting refiners 62B and 64B "on-the-line" is like that stated for refiner 60B with the timing being
such as to stagger the dumping of the batch charges into reservoir 128B. Obviously, the slurry circulating component of reservoir 128B is put in operation when slurried stuff is first admitted into the reservoir.

Impulse signals from slurry level sensing device 130B are employed to respond so as to effect an increase or decrease in the speed of refiner drives 132B, 134B and 136B to expedite or slow the refeeding action of the respective refiners in accordance with the demand for furnish from reservoir 128B, or to cut in or cut out refiners as required, or to operate the refiners in series with a headbox arrangement, and also to cause the speed of blende 46B to be varied in accordance to slurry rate demands on reservoir 128B, by any suitable instrumentations incorporated in a control panel 138B.

To render the line "A" refining phase operative and after a circulation flow has been established in the material slurry-conditioning phase, 60A is put in operation in the dry condition, with a variable speed drive 140A adjusted to moderate low speed, with motorized dump valve 142A set in closed position, with headbox valve 144A being open and headbox valve 146A being closed, with viscosity sensing device 148A being activated, and with a slurrying phase blender variable speed drive 150A adjusted to moderately low speed. Headbox valve 42A is then modulated opened to allow slurry to fill the reservoir of refiner 60A to a normal operating level, at which time a slurry level sensor 154A may then signal impulses for automatically regulating the position of headbox valve 42A through any suitable instrumentations incorporated within the control panel 156A, to maintain constant slurry level within refiner 60A, during which time a slurry recirculating flow has been established through slurry well 158A in which the rotating element of the viscosity-sensing device operates.

As the viscosity value of the slurry being circulated through headbox valve 144A and back to refiner 60A begins to approach the desired viscosity value, the slurry-circulating component of reservoir 162A is put in operation and the motorized dump valve 142A is modulatedly opened allowing a sufficient portion of the slurry being circulated to flow to refiner 162A while simultaneously, maintaining a constant viscosity value at slurry well 158A which in turn cause valve 42A to be automatically positioned to allow an equivalent volume slurry flow to be fed to refiner 60A.

A slurry-agitating component 170A may be of a type such as exemplified in application Ser. No. 315,589 for keeping the slurry well agitated to provide a homogeneous slurry condition. The direct swirl effects such type components impose on the contents because of the exposure of a portion of the rotor thereof, and the recirculation effects of flows circulated through a conduit 172A, which is a similar arrangement to that of reservoir 128B of line "B."

After reservoir 162A fills to its normal operating level, a liquid-level-sensing device 174A signals impulses thereafter transmitted to control panel 156A may then be utilized by adequate instrumentations to modulatingly increase or decrease the slurry flow to reservoir 162A by automatically modulatingly controlling dump valve 142A in accordance with variations of slurry levels within reservoir 162A, when out flows from that reservoir range within the normal capacity of refiner 60A to maintain a desired constant viscosity value of the slurry circulated through slurry well 158A and back into the reservoir of refiner 60A.

Likewise, signal impulses from slurry level sensor 154A caused by variations in slurry levels in refiner 60A through instrumentation of any suitable type are utilized to accordingly modulatingly regulate headbox valve 42A in maintaining adequate flow to refiner 60A equivalent in volume to that flowing into reservoir 162A.

When the slurry volume flowing to reservoir 162A begins to exceed the refining capacity of refiner 60A in maintaining the desired viscosity value of the slurry recirculated back to the refiner reservoir through slurry well 158A at a low speed range it was put in operation under, then through suitable instrumentation, the speed of the refiner rotor may be modulatingly increased according to the change in speed of drive 140A within a reasonable economical range, for developed characteristics of fibers with respect to dry web strength properties are variably affected by refiner rotor speed variations.

When the slurry volume flowing to reservoir 162A is such that the desired viscosity value of the slurry recirculated through slurry well 158A is no longer being maintained before the maximum desired refiner rotor speed is reached, then by suitable instrumentations, the value can be cut in on the line in series with refiner 60A, by putting refiner 62A in operation while in dry condition and at adjusted moderately low speed with a dump valve 176A being closed, a headbox valve 178A being closed, a headbox valve 180A being open, and then modulatingly opening headbox valve 144A, then modulatingly closing headbox valve 144A, then increasing the speed of the rotor of refiner 60A to the maximum desired speed until the reservoir of refiner 62A is at normal level, at which time dump valve 176A can be modulatingly opened and dump valve 142A can be modulatingly closed allowing full recirculating slurry flow passing through a conduit 182A to flow into the reservoir of refiner 62A, at which time a slurry level sensor 184A can be cut in on the controlling of headbox valve 42A and a viscosity sensor 186A in establishing a recirculating slurry flow through slurry well 192A, after which the rotor speed of refiner 60A can be modulatingly lowered to a speed at which the viscosity value at slurry well 192A continues at the desired level, either by manual console control or automatically by suitable instrumentation.

After refiner 62A has been cut in on the processing line, headbox valve 144A may be modulatingly opened sufficiently to allow a recycle flow back into the reservoir of refiner 60A equal to the recycle flow back into reservoir 62A, merely to equalize the load effects between refiners when the speed of both refiners may be adjusted to operate at like speeds.

For either increased refining effects or increased flows of the same constant beating degree, so called, refiner 64A may be cut in on the line by reference to headbox valve 62A, by the same procedure as outlined. Alternatively, if desired, all three refiners may be operated in parallel.

Reservoirs 162A and 128A may be of different volume capacities but are of equal height and equipped with agitating components 170A and 196B respectively, having the same discharge flow characteristics, and recycling respective conduits 172A and 198B, and by the control of flow and conduit resistance, as well as conduit connections to respective furnish proportioning phase stock metering pumps 204A and 204B.

The furnish ingredient proportioning phase is essentially composed of: (1) the pair of matched positive displacement rotor type metering pumps 204A and 204B, having like characteristics and discharge lines of substantially equal resistance are driven by a remote manipulatable variable speed driving means, such as shown mechanically in schematic FIG. 2, or any other usual similar or like differential ratio adjustable responsive means further indicated schematically in flow line diagram FIG. 1, whereby to regulate in a similar manner, instrumentations for remotely controlling variable speed AC or DC electrical controlling pump driving components 206A and 206B respectively; (2) a composite furnish mixture receiving reservoir 208 of suitable capacity receives the meter proportioned furnish ingredient slurries, the reservoir being equipped with a suitable reservoir agitating-and-recirculating-type component 210 for adequately blending and elevating the composite furnish to flow to the delivery and circulating headbox 212; (3) a controller panel 214 containing the instrumentations for varying the speed of metering components 204A and 204B separately to desired speed differential ratios therebetween, for establishing and maintaining desired proportioning ratios of the slurries in composing the furnish mixture, and also for varying the speed of metering components simultaneously by which to vary the furnish volume flow in-
According to machine forming capacity demand, all by the manipulation of the respective variable speed drives 206A and 206B, and also for controlling the operation of component 210, in agitating the slurry within a reservoir 208 and a circulation of slurry to headbox 212 for recirculation to the reservoir 208 and also to supply line 224 to a subsequent slurry dilution phase. Component 210 may also be additionally operated and controlled as a refining component when so required.

Assuming a furnish mixture is to be composed of 80 percent short-fiber pulp refined in line “A” and 20 percent of long-fiber-type pulp refined in line “B,” then by suitable instrumentation, the rotative speed of pumps 204A and 204B would be adjusted to a relative speed differential of 4 to 1, that is pump 204A would rotate 4 revolutions to one revolution of pump 204B and any further speed variation to meet flow volume demand would continue in that ratio relationship until a different ratio relationship is adjusably made.

Regardless of the differential ratio relationship between said pumps that may be selected, furnish-level-sensing device 516 provides the signal impulses by which the speeds of both pumps 204A and 204B are simultaneously regulated in accordance to the furnish stuff demand.

Where stock material types permit, other modified arrangements are possible as for example by intensifying the fiber treatment within the slurring phases of line “A” and “B,” the refining phase of line “A” particularly may be simplified, if not eliminated, allowing the furnish proportioning phase to be incorporated next to the slurring phases of both lines by having a metering pump 204A and conduit 44B leading to metering pump 204B, in which case supply line 224 would conduct the so-combined stocks in a selective proportioned ratio directly to the line “B” refining phase.

The instrumentation by which control of the differential speed relationship between companionly matched metering components are externally motivated and controllably manipulated to predetermined selective differential speed ratios for proportioning slurries accordingly as drawn from separate sources, and blending same into a desired predetermined composition as a composite mixture thereby, and further variously controlling the volume flow rate of said proportioned and blended composite mixture in accordance to machine forming rates for papermaking and other purposes, may be of various types and forms such as suitably arranged cone-pulley and other so called vari-speed mechanical drives speed changing devices and/or eddy-current and magnetic electrical drives or combinations of such as may be made adjustably responsive to variations in reservoir slurry levels by any suitable impulse communicative and cooperatively reactive accessory means.

FIG. 2 is a schematic diagram that shows possibly the most simple and also possibly the most cumbersome means of adjusting slurry-metering components 204A and 204B to a particular selective differential speed ratio between the said meters, by causing the shifting of belt 554 on pulleys 550 and 552 by the manipulation of a motorized screw-type belt positioner (not shown).

Likewise, belt 556 on cone pulleys 558 and 560 may be controllably maneuvered by a similar motorized type belt positioner (not shown), by which the volume output of the power driven metering components 204A and 204B may be varied over a wide range at the proportioning ratio provided by the belt positioner with respect to cone pulleys 550 and 552, even though driving motor 562 be of the constant speed type.

Obviously, belt 554 may be positioned by remote control in accordance to comparison between transmitted tachometer readings by which a desired differential in speed ratios between meter components regardless of the total combined discharge rates may amount to or may be adjusted to.

Whereas belt 556, by suitable communicative circuitry, is caused to be automatically positioned in accordance with reservoir slurry levels that are effected by the machine forming slurry supply demand.

Obviously all control panels may be grouped together at a central control center.

Normally, the density value of the stock being refined may preferably be as high as the refining and conduit system will accommodate, since the higher density slurries have the advantage of less fiber cutting action in apparatus employing the bar against bar principle. Also, greater fiber capacity is possible per reservoir volume.

Obviously, for machine forming purposes the furnish is diluted to thin slurries of more or less in the neighborhood of one-half of 1 percent, (0.50 percent) density value, by so-called consistency regulators. Such consistency regulators are not only troublesome, but by the principle on which such apparatus functions, are only approximately accurate at best, and are not always readily adaptable to positive proportioning ratios of liquid to fiber on an air dry fiber basis.

By extending the automatic integrated controlling embodiments of this invention as already taught herein, the furnish flow supplied by conduit 224 may be proportionally diluted with liquid drawn from conduit 28 by method and means similar to that employed in proportioning the separately refined slurries from process lines “A” and “B,” to suitable machine forming densities within a machine slurry dilution and blending phase (not shown).

Such an integratedly automatically controlled dilution phase would be a duplication in essence of that already shown in the refined slurry proportioning and blending phase functioning under instrumentality of control panel 214 and would include a slurry-proportioning component of a type similar to component 204A and a dilution liquid-proportioning component similar in type to component 204B and respective variable speed drives similar to 206A and 206B, by which to differentially and selectively manipulate the speeds of each of the proportioning components to a differential relative speed ratio for obtaining a desired machine forming constant density flow to a suitable small capacity receiving reservoir serving a similar function performed by reservoir 208.

Such a reservoir would then be the machine slurry supply (low density) reservoir and would be fitted with an agitating and slurry impelling component similarly arranged as component 210 for delivering the low density slurry to a recycling headbox similar to 212, from which the forming machine may be fed by any convenient means arrangement, allowing the overflow or surplus to spill back to said low density machine supply reservoir.

This reservoir would also be equipped with slurry level sensing devices identical to 516 by which signal impulses would be utilized to manipulate the speeds of the slurry and liquid metering components in accordance to the forming machine flow demand.

Any fluctuation in the machine demand would effect the slurry level within reservoir 208, which in turn would cause a speed up in the processing within both lines “A” and “B” all the way back to the proportioning of material and liquid rates of the slurring phase at the very beginning of the processing operation by virtue of the slurry-level-sensing devices incorporated within the respective reservoirs at the various phases of the processing system.

Under such an arrangement a valve similar to valve 518 would normally be wide open during normal operation.

Since the machine slurry dilution phase just described is a duplication in essentials with the furnish composing phase respective to principles and instrumentation functionalities, such is not shown in the schematic arrangement of FIG. 1, even though sufficiently integratedly connected for interreactive and automatic responsive controlling effects.

In the foregoing disclosures given herein, it has been shown how refined stocks may be proportioned to form composite furnish mixtures of a predetermined selective composition, the mentioned fiber percent short fiber stock to 20 percent long fiber stock being only by way of example out of the many possible variable ratios that may be readily determined and checked by tachometer readings reflecting the adjusted
speeds of the metering components which proportion the slurry and dilution liquid flows. The tachometers are equally important in establishing flow ratios for desired density valves in the machine forming density range. Assume for example that the furnish mixture happens to be 3.5 percent density value on an air-dry fiber basis, by virtue of the programming of the proportioning of material to liquid ratio at the slurring phase, which means that on the passage of selected multiples of 3.30 gallons of liquid, like multiples of the equivalent of one pound quantities of air-dry fiber material would be automatically admitted into the slurring phase provided the material bundle weight units and liquid quantity units were adjusted to that ratio, or rather the liquid unit quantities were adjusted to normal material bundle or bail sizes where practical.

A 0.50 percent machine forming slurry density represents a ratio of 23.82 gallons liquid per pound of A.D. stock, or 23.94 gallons of slurry volume. Likewise, a ratio of 3.30 gallons liquid per pound of A.D. stock represents 3.42 gallons of slurry volume. In this particular instance, the ratio of slurry volumes of the 0.50 percent density to the 3.5 percent density slurry is in the order of a 7:1 ratio. By adjusting the metering component speeds as indicated by the tachometer reading comparisons to ratios that may be derived from standard tables, the invention provides the means of automating the proportioning of materials and liquid simultaneously within multiple process lines to suit refining requirements therein, and the accurate proportioning of the separately processed slurries into a composite furnish flow, and the accurate dilution of the furnish slurry to machine forming densities.

While process lines A and B have been described as a means of simultaneously regulating and controlling the processing of the ingredients of a composite furnish mixture separately because of the wide and differing refining degree such ingredients may differentially require between such pulps as the various types, grades, forms and conditions of the cotton and linen materials as well as the various qualities of the sulfate pulps due to the species of pulpwood and the treatment used in the production thereof and the sulfate pulps as compared with the soda pulps and the mechanically ground wood pulps, this invention also teaches the means of regulating and controlling the operation of either line A or B or both independently as single line systems entirely apart of the other line and to separate forming machines, merely by providing such respective line with a separate furnish dilution phase with instrumentation that function similar to that arrangement shown under control panel 214, by which each such single line system may supply a separate forming machine with composite furnish mixtures of a type made up of ingredients that will tolerate identical refining treatment without undue or excessive deterioration of one or the other ingredients, such as the overprocessing of one while underprocessing the other, subsequently meter proportioning to selective ratios with liquid vehicle to machine forming densities at rates in accordance to machine forming demand.

As an illustration, line A may be independently operated to receive unit quantities of pulp 6A composed of selected ratios of sulphite and groundwood pulp suitable for a particular end product, or other combinations such as sulfate and soda pulps, at processing rates in accordance to machine forming demand, merely by providing metering pump 204B with liquid vehicle for obtaining slurry densities at machine forming values.

In such an arrangement, the machine headbox would eliminate the need for headbox 212, allowing all recirculation slurry to return to reservoir 208, whereby the slurry level control instrumentalities at reservoir 208 would then initiate the processing rate of the entire processing line. Likewise, line B may be similarly arranged to be operated independently in the processing of furnish compositions made up from the various grades of pulps of the hair seed family origin and/or pulps of other origin, in selected ratios incorporated in the unit quantities indicated as bundles 6B of dia-

gram 1, and processing such composite combinations to a particular degree of viscosity at rates and densities in accordance to a machine forming demand, by providing line B with a slurry dilution phase similar to that just described for line A and functioning under a control panel similar to the panel 214 arrangement for supplying a separate forming machine.

Or if desired, by suitable interconnections, lines A and B may be operated integrally for supplying a single forming machine or independently to supply separate forming machines, in either case at processing rates initiated by said forming machine or machines, at selective densities suited thereto.

Likewise, by suitable interconnections (not shown) two or more forming machines may be simultaneously supplied by slurries metered from each of both of lines A and B, whereby each forming machine may be provided with an entirely different composition ratio of furnish ingredients from that of the other or others in which case the slurry-level-sensing instrumentalities of reservoirs 162A and 128B would initiate the processing rates within each of the respective lines A and B as slurries are selectively drawn at different ratios from said respective mentioned reservoirs in making up the two or more separate furnishes of different ratio formation for the two or more separate forming machines.

I claim:

1. An automated continuous flow multiphase processing system responsive to the demand of the forming machine comprising:
   A. a machine slurry blending phase including the steps:
      1. selectively proportioning continuous flows of refining density stock with liquid to a predetermined stock volume to liquid volume ratio by the adjusting of the speed differential ratio between a pair of metering pumps for obtaining and maintaining desired machine forming constant density blended slurry,
      2. continuously circulating a flow of the blended slurry at a machine supply reservoir from which a machine slurry flow may be automatically and controllably drawn in accordance with the machine forming demand,
      3. varying the combined flow volume from the pair of metering pumps, without altering the differential speed ratio therebetween by simultaneously varying the speeds of the metering pumps for regulating the total volume of both meter pump flows in accordance with the machine demand as initiated and reflected in the variance of the slurry volume within a machine supply reservoir,
   B. a refining phase preceding the machine slurry-blending phase and including the steps:
      1. regulating the volume of slurry inflow to the refining phase responsively to and in accordance with the volume of refined slurry outflow, with the volume of refined slurry being initiated by the machine demand therefor as consumed in the proportioning thereof in the machine slurry blending phase,
      2. automatically varying a slurry recycle through the refining means for prolonging the slurry retention within the refining means and at varying flow rates in response to viscosity variations within the refining phase,
      3. automatically varying the rate of the refining by increasing the speed of the refining according to viscosity variation of the slurry during processing within the refining phase for maintaining a constant stock viscosity of prerefrained nature,
      4. charging the so-refined stock slurry into a circulating reservoir, with the reservoir volume serving as the determinant of the volume rate of unrefined slurry input to the refining phase, as so-initiated by the machine demand therefor,
      C. a continuous flow conditioning-slurrying-blending phase, preceding the refining phase and including the steps:
1. controlling the input flow of predetermined unit quantity charges of unrefined bulk fibrous material and of liquid by measuring the flow of the latter for effecting a flow variance of the former for the maintenance of a predetermined fiber-to-liquid ratio,

2. reducing the so-proportioned fiber-to-liquid mass to a continuously flowing stock slurry of selected density value reflective of the flow measuring for assuring the predetermined fiber-to-liquid ratio,

3. charging the so-reduced stock slurry into a circulating blending type reservoir for maintaining a continuous blending slurry flow to a conditioner while extracting from the so-circulated flow a flow to the refiner phase, with the refiner phase flow volume rate being the determinant of the input rates of flow of the charges of bulk fibrous materials and of liquid to the conditioner as reflected in the reservoir volume variance as initiated by the machine demand.

2. in an automated continuous-flow multilime stock preparation system having separate lines constituting the numerous phases necessary to process separately unlike materials from the bulk unrefined condition to selective predetermined refined slurry viscosity values suitable for blending into a desired type of composite furnish slurry of predetermined selective proportions of each preparatory to further liquid blending to machine forming density, with the rate of processing in each of the lines in conformity with the demand rate for the respective type of furnish ingredient in proportion to the composition of the furnish and with the composite furnish rate being initiated by the machine forming demand therefor in the form of a slurry of a selected predetermined machine forming density, comprising the steps:

1. simultaneously, in each separate processing line of the respective material conditioning and slurring and circulating phases, controlling the input flow of predetermined unit quantity charges of unrefined bulk different type fibrous materials and of liquid by measuring the flow of the latter for effecting a flow variance of the former with a resultant maintenance of a predetermined fiber-to-liquid ratio within the respective processing lines,

2. simultaneously, in each processing line, reducing the so-proportioned fiber-to-liquid charge to a continuously flowing stock slurry of selected density reflectant of the measuring for assuring a like fiber-to-liquid ratio of the unlike materials within the respective processing lines,

A. within the respective separate processing line material “conditioning-slurring-circulating” phases,

1. simultaneously proportioning different types of fibrous materials in unit quantities with respect to unit quantities of liquid for equal and like ratios within both lines,

2. reducing the so-proportioned fiber-to-liquid masses to continuous flowing stock slurries of equal and like density values, with both lines,

3. charging the so-reduced slurries into circulating type blending reservoirs, for maintaining a continuous blended slurry flow to conditioners, with provision for extracting from the so-circulated flows, feed flows to the subsequent respective refining phases,

B. within the respective subsequent refining phases, both preceding a composite furnish proportioning and blending phase,

1. simultaneously regulating slurry inflow to the refining phase responsively to and in accordance with the volume of refined slurry outflow, in each separate respective process line refining phase, each such outflow being as determined by the proportioning of the respective stocks in the making up of a predetermined selective composite furnish mixture ratio of the separate line processed different type stocks, each at a flow rate as such so-proportioned composite furnish flow is initiated by the machine demand therefor,

2. processing the main part of the furnish material, generally requiring the least processing of the different type materials, on a continuous flow basis, in which the stock is variously recycled within that type of refining means in steps only in accordance with the requisite viscosity development,

3. varying the speeds of the refiners for supplementarily boosting viscosity development values in accordance with the slurry volume demand flow in the respective line refining phase,

4. simultaneously batch processing the more difficult to process type of the unlike materials in multiple continuous recycle types of refining means, all arranged to operate in parallel only as required to meet a refined slurry volume outflow demand of predetermined selective viscosity value, with the refining being separately time staggered for charging and discharging for uniformity of stock viscosity value of the outflow,

5. varying the rotative speeds of the so-parallel operated refining means units for boosting the slurry viscosity of each to a like selective value,

6. charging the refined slurry flows of both line refining phases to the respective line refined stock continuous-recycle blending-type reservoirs, the volume-variation-sensing devices of which alert controlling instrumentalities for that line phase, in accordance with predetermined selected degrees of refinement with respect to viscosity values at slurry volume demand rates as made by a subsequent furnish material receiving and proportioning phase,

C. a furnish proportioning-blending phase with the steps,

1. of selectively proportioning the volume rates of continuous flows of refined slurry of refining density, as drawn from the different process line refined stock reservoirs, in the forming of a composite furnish mixture in predetermined ratios thereof, by accordingly adjusting the differential speed ratio between the respective interdriven metering pumps to obtain and maintain a composite furnish mixture in a continuous nonbatched flow, and

2. discharging the so-formed continuous-flow-type composite furnish mixture within a continuous-cycling-type blending reservoir,

3. varying the volume flow rate of the so-formed continuous-flow-type composite furnish mixture, without altering the ratio of the furnish composition, by simultaneously equally varying the speeds of both furnish ingredient metering pumps automatically in accordance to furnish reservoir volume variance of the furnish mixture within the furnish reservoir, and

D. in a machine forming slurry blending phase with the steps: 1. of selectively proportioning continuous flows of a composite furnish mixture stock of refining density with slurry dilution liquid, to a predetermined furnish stock-to-liquid ratio, by adjusting the speed differential ratio between both the furnish stock and the liquid interconnectively driven metering pumps, to obtain and maintain a selected machine forming constant density slurry, and

2. of continuously circulating the so-blended slurry at the machine supply reservoir, from which circulation flow the machine slurry flow may be automatically and controllably drawn in accordance with the machine forming demand, and

3. of varying the combined flow volume from both metering pumps, without altering the differential speed ratio therebetween, by varying the speeds of both pumps simultaneously differentially speedwise, by which the total volume of both meter pump flows are automatically regulated in accordance with the machine volume demand as reflected in the variance of the slurry volume within the machine supply reservoir.